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A PROMOTION POLICY MODEL FOR LABORATORY WORKFORCE PLANNING.(U)
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A PROMOTION POLICY MODEL FOR LABORATORY WORKFORCE PLANNING

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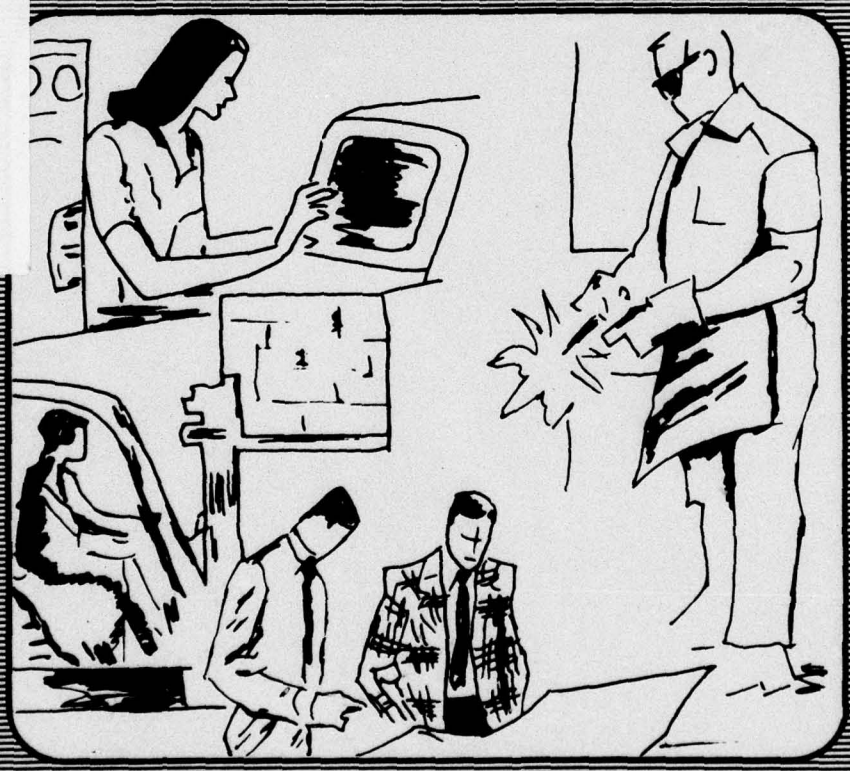

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(6) A Promotion Policy Model for Laboratory Workforce Planning,

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Introduction

There has been a great deal of concern within the Navy community over the last six years with regard to the control of manpower resources. These concerns have manifested themselves in recent times in the form of manpower ceiling allocations, the allocation and control of high grade positions, average grade constraints, promotion restrictions, and hiring freezes.

The implementation of some of these manpower policies has created some other problems. For example, the control of high grade positions has resulted in the tremendous increase in the number of mid-level positions in the General Schedule grades GS-9 through [illegible] (especially at the GS-12 level). At the present time, there seems to be major concern that we must focus upon the GS-12 problem within the Navy. It has been suggested that a possible solution would be to attempt to control promotions of employees at all levels so that a build up of employees at certain levels is avoided. This would be accomplished in conjunction with other personnel policies such as a more thorough position management and position classification system.

In an attempt to deal with these problems, a promotion policy model (PPM) has been developed. The structure of the PPM is similar to the Flexible Equal Employment Model (FEEO) developed by Charnes, Cooper, Lewis and Niehaus [17]. A review of the model structure is given in Appendix A of this paper. In this application all that has been changed in the job categories were limited to the General Schedule grades

with the junior professionals in grades GS-5, 7, and 9 split out as separate categories. Two applications of the PPM are presented, one using the graded employees at the Naval Underwater Systems Center (NUSC) and the other using the graded personnel of the Director of Laboratory Programs (DLP) which consists of all the Navy RDT&E,N laboratories commanded by the Chief of Naval Material.

The PPM is designed to provide estimates of the numbers of people that should be hired, fired, and promoted in a given set of manpower categories to meet a set of future manpower requirements (goals) for these categories as closely as possible, subject to the contraints of the manpower system. A cost is associated with hires, fires, goal deviations, and deviations from the number of promotions based on the historical promotion rates (see (1) for an example of a model allowing for variable numbers of transfers between manpower categories). The user specifies the relative cost of these occurrences; the model is designed to minimize the total cost.

For all of the runs, the initial aboard is as of 30 September 1976, the projected time periods are of yearly duration (and except in one case three in number), and the overall manpower ceiling is set equal to the sum of the goals for the corresponding time period. The cost per person of exceeding a given goal is set equal to the cost falling short of that goal; similarly, the costs of deviations from the historical promotion rates do not depend on the direction of the deviations.

The results of the model runs for NUSC and DLP indicate that the manpower goals as given cannot be met without cutting back on promotions. The specific alternatives along with the magnitudes of the promotion reductions suggested by the model runs are provided in the body of this paper. This

will be followed by a discussion of the implementation strategy for more general Navy use.

NUSC Application

The manpower categories used for the NUSC runs of the PPM consist of GS grades 1-17 containing employees who are not junior professionals (JP's) as well as grades 5, 7, and 9 JP's. JP's who are promoted advance two grades, while non-JP's advance one grade. JP's and non-JP's retain their respective identities when promoted, except when grade 9 JP's are promoted to grade 11. The historical promotion and separation rates, initial populations (aboard), and manpower goals were developed by the NUSC. The transition rates appear in Figure 1, while the initial aboard and goals are contained in each run. The first eight runs varied in differences in the costs assigned to various types of action as shown in Figure 2. In this first set of runs goals were set only for the last period to allow the maximum amount of flexibility in the runs.

The results of the first three runs (1-3) are identical. In each case, the highest cost is assigned to fires and the lowest cost to hires. Since goals are given for only the end of the last time period, all hiring and firing occurs in that period; the reason is that, because of the non-zero separation rates, the last period is the only one in which hiring and firing can remedy deficiencies and excesses respectively on a one-for-one basis. Since hires cost less than deficiencies, none of the latter occur; similarly, excesses are retained to avoid firing. The only excess occurs in grade 12. Some hiring and promotion deviations occur during the last period.

PROMOTION PLANNING MODEL
NAVAL UNDERWATER SYSTEMS CENTER (NUSC) EXAMPLE

PROMOTION AND SEPARATION RATES

CATEGORY TYPE	GRADE	PROMOTION RATE	SEPARATION RATE
Non-JP	1	1.000	.000
Non-JP	2	.333	.333
Non-JP	3	.429	.122
Non-JP	4	.149	.051
Non-JP	5	.191	.10
Non-JP	6	.167	.083
Non-JP	7	.312	.043
Non-JP	8	.376	.025
Non-JP	9	.130	.041
Non-JP	10	.294	.071
Non-JP	11	.141	.024
Non-JP	12	.028	.027
Non-JP	13	.039	.036
Non-JP	14	.021	.048
Non-JP	15	.000	.067
Non-JP	16	.000	.125
Non-JP	17	.000	.000
JP	5	.833	.056
JP	7	.529	.082
JP	9	.630	.054

Figure 1

PROMOTION PLANNING MODEL
NAVAL UNDERWATER SYSTEMS CENTER (NUSC) EXAMPLE

RELATIVE PRIORITIES (COSTS) PER PERSON

NATURE OF ACTION	ALTERNATIVE 1	2	3	4	5	6	7	8
HIRES	1	2	2	1	1	1	1	10
FIRES	7	7	7	10	10	100	1000	1000
ABOVE GOAL	3	3	4	100	100	10	100	100
BELOW GOAL	3	3	4	100	100	10	100	100
PROMOTIONS ABOVE HISTORICAL RATE	2	4	4	100	100	100	10	1
PROMOTIONS BELOW HISTORICAL RATE	2	4	4	100	100	100	10	1

Figure 2

From the above, it is apparent that the goals cannot all be met without resorting to firing if the current promotion rates are retained. Run 4 is designed to study a policy in which the current promotion rates are retained, the goals are met, and a minimum number of people are fired. To do this, goal deviations and promotion deviations are assigned the highest cost, firing an intermediate cost, and hiring the lowest cost. It is seen that this policy results in a relatively large number of people being fired in some of the middle grades. In periods 1 and 2 there are net gains in some of the categories, even though no hiring occurs until the last period. The reason is that the number of people promoted into some of the grades exceeds the number leaving the respective grades due to promotions and separations. Even increasing the number of periods to five (Run 5) does not alleviate this problem; in fact, the number of excesses in some grades actually increases. Run 6 is similar to Run 4, except that fires are assigned a higher cost than goal deviations. In this case, the excess personnel are retained rather than fired.

In Run 7, the cost of promotion deviations is set below that of fires and goal deviations, but still above that of hires. In this case, fires and goal deviations are eliminated. The price paid is that promotions are drastically reduced in the middle grades; in particular, promotions are frozen in grades 11 and 12 for the last period. Run 8 is similar to Run 7, except that promotion deviations are assumed to be less costly than hires; this results in a slight reduction in the total number of hires, but still further cutbacks in promotions.

In order to bring the issues into sharper focus, an extensive number of runs were tested with goals for all three periods. Several runs were made to evaluate the inclusion of an average grade constraint into the model. These average grade runs showed the use of such a device with all the other constraints being imposed to be of questionable value with the ceilings being much more constraining factors. Thus for the remainder of the runs the average grade constraint was relaxed so that it no longer affected the outcomes.

A final set of runs were made to examine the possibilities of maintaining junior profes[illegible] hiring and promotions. Also included was the assumption that firing would [illegible]one only as a last resort. The relative priorities for these runs are given in Figure 3. The results of Run W in Figure 4 show that promotions are cut considerably with grade imbalances projected in low grades (GS 2-3) and in the GS-12's in Period 1. Also, there is little hiring of any personnel at all in Period 1 and little hiring of JP's until Period 3.

In Run X the policy was further shaped by putting relatively large penalities on deviating from the historical promotion rate for JP's. The results of this run showed that the grade imbalances moved up from the GS-12's up to the higher grades with the low grade imbalances persisting to make up the difference. Since these results are unacceptable, additional weights were put on promotions above the historical rate for GS-13's and above in Run Y. This also turned out to be unacceptable as the weights should have been placed down to the GS-12 level if the GS-13 and above goals were of particular concern.

PROMOTION PLANNING MODEL
NAVAL UNDERWATER SYSTEMS CENTER (NUSC) EXAMPLE
RELATIVE PRIORITIES (COSTS) PER PERSON

NATURE OF ACTION	ALTERNATIVE W	X	Y	Z
Hires	10	10	10	10
Fires	1000	1000	1000	1000
Above Goal				
For Grades 13-17	100	100	100	2000
For Other Grades	100	100	100	100
Below Goal	100	100	100	100
Promotions Above Historical Rate				
For Non-JP's Below Grade 13	1	1	1	1
For JP's	1	200	200	200
For Grades 13 and Above	1	1	500	1
Promotions Below Historical Rate				
For Non-JP's	1	1	1	1
For JP's	1	200	200	200

Figure 3

PROMOTION POLICY MODEL - RUN W

PERIOD 1

CATEGORY TYPE	GRADE	ABOARD SEP 76	HIRES	FIRES	PROMOTIONS FROM CATEGORY EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 77	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	0	0	1	-1	0	0	1	1	0
NON-JP	2	3	0	0	1	1	2	1	0	1	-3
NON-JP	3	48	1	0	21	0	21	6	25	48	-23
NON-JP	4	195	5	0	29	-8	21	10	190	190	0
NON-JP	5	136	0	0	26	-16	10	15	132	132	0
NON-JP	6	60	0	0	13	-3	7	5	68	68	0
NON-JP	7	93	0	0	29	-23	6	4	30	93	0
NON-JP	8	79	0	0	29	-23	6	2	77	77	0
NON-JP	9	123	0	0	16	-12	4	5	120	123	0
NON-JP	10	85	0	0	25	-25	0	6	83	83	0
NON-JP	11	490	0	0	69	-23	46	12	476	476	0
NON-JP	12	719	0	0	20	4	24	19	712	690	22
NON-JP	13	360	0	0	14	-3	11	13	360	363	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	45	0	0	0	1	1	3	45	45	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	1	0	0	1	1	0
JP	5	18	0	0	15	-10	5	1	12	12	0
JP	7	85	0	0	45	-21	24	7	59	59	0
JP	9	92	0	0	58	-15	43	5	68	64	4
TOTAL		2779	6	0	411	-176	235	122	2663	2663	0

SEP 77 CEILING: 2663

SEP 77 AVERAGE GRADE: 10.29 (TARGET: 11.00)

Figure 4

PROMOTION POLICY MODEL - RUN W

PERIOD 2

CATEGORY TYPE	GRADE	ABOARD SEP 77	PROMOTIONS FROM CATEGORY HIRES	FIRES	EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 78	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	1	0	1	0	1	0	1	1	0
NON-JP	2	0	2	0	0	0	0	0	3	3	0
NON-JP	3	25	36	0	11	0	11	3	47	47	0
NON-JP	4	190	23	0	28	0	28	10	186	186	0
NON-JP	5	132	3	0	25	-6	19	15	129	129	0
NON-JP	6	58	0	0	13	6	16	5	67	67	0
NON-JP	7	90	0	0	28	-10	18	4	88	88	0
NON-JP	8	77	0	0	28	-14	14	2	75	76	0
NON-JP	9	120	0	0	16	-4	12	5	117	117	0
NON-JP	10	83	0	0	24	-16	8	6	81	81	0
NON-JP	11	476	0	0	67	-60	7	11	466	466	0
NON-JP	12	712	0	0	20	4	24	19	676	676	0
NON-JP	13	360	0	0	14	-3	11	13	360	360	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	85	0	0	0	1	1	3	85	85	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	0	0	0	1	1	0
JP	5	12	6	0	13	-5	5	1	12	12	0
JP	7	59	0	0	31	-31	0	5	59	59	0
JP	9	68	0	0	43	-43	0	4	64	64	0
TOTAL		2663	71	0	359	-184	175	119	2621	2621	0

SEP 78 CEILING: 2621

SEP 78 AVERAGE GRADE: 10.22 (TARGET: 11.00)

Figure 4 (continued)

PROMOTION POLICY MODEL - RUN N

PERIOD 3

CATEGORY TYPE	GRADE	ABOARD SEP 78	HIRES	FIRES	PROMOTIONS FROM CATEGORY EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 79	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	1	0	1	0	1	0	1	1	0
NON-JP	2	3	1	0	1	0	1	1	3	3	0
NON-JP	3	43	25	0	20	0	20	6	82	82	0
NON-JP	4	186	12	0	28	0	28	9	186	186	0
NON-JP	5	129	11	0	25	0	25	14	129	129	0
NON-JP	6	57	0	0	10	10	20	5	57	57	0
NON-JP	7	88	11	0	27	0	27	5	88	88	0
NON-JP	8	75	2	0	28	0	28	2	76	75	0
NON-JP	9	117	0	0	15	8	23	5	112	117	0
NON-JP	10	81	1	0	24	0	24	6	81	81	0
NON-JP	11	466	0	0	66	-23	43	11	466	466	0
NON-JP	12	676	0	0	19	5	24	18	676	676	0
NON-JP	13	360	0	0	14	-3	11	13	360	363	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	45	0	0	0	1	1	3	45	45	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	0	0	0	1	1	0
JP	5	12	11	0	10	0	10	1	12	17	0
JP	7	59	26	0	31	0	31	5	59	59	0
JP	9	64	2	0	42	-11	29	3	64	64	0
TOTAL		2621	114	0	362	-12	350	114	2621	2621	0

SEP 79 CEILING: 2621

SEP 79 AVERAGE GRADE: 10.22 (TARGET: 11.00)

Figure 4 (continued)

Using Runs W, X, and Y as trial runs, a final alternative was constructed to see if all the conditions and constraints could lead to an implementable promotion policy. In Run Z the high weights on the promotions above the historical rate for GS-13's and above were removed. In its place are high weights on positive goal deviations for GS-13's and above which is the real control that was desired. The weights on the JP promotions were continued so as to give a high priority to keeping the promotions at the historical rates. As shown in Figure 5, this increased the goal imbalances at GS-12's and at GS-2 and GS-3. Hiring of JP's was restricted in Period 1 but indicated at good levels in Period 2 and 3.

This last series of runs showed that the GS population was so highly over-constrained that almost any policy results in undesirable side effects. The model works quite well with the needed action in the policy decisions involving the external constraints. Since at this writing these decisions are under discussion, no further comments will be made on the model runs at NUSC.

DLP Application

Having gained experience in running the PPM for the NUSC, it was considered worthwhile to construct a similar model for the workforce of the Navy labs as a whole. With a larger population with which to work, a more detailed manpower categorization becomes possible.

The manpower categories for the Director of Laboratory Programs (DLP) runs are specified by grade and major GS occupation group of the Computer Assisted Manpower Analysis System (CAMAS) developed and supported by the Navy's

PROMOTION POLICY MODEL - RUN 7

PERIOD 1

CATEGORY TYPE	GRADE	ABOARD SEP 76	HIRES	FIRES	PROMOTIONS FROM CATEGORY EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 77	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	0	0	1	-1	0	0	1	1	0
NON-JP	2	3	0	0	1	1	2	1	0	3	-3
NON-JP	3	49	0	0	21	0	21	6	24	48	-24
NON-JP	4	195	0	0	29	-13	16	10	190	190	0
NON-JP	5	136	0	0	26	-16	10	15	127	132	-5
NON-JP	6	60	0	0	10	-3	7	5	58	58	0
NON-JP	7	93	0	0	29	-23	6	4	90	90	0
NON-JP	8	79	0	0	29	-23	6	2	77	77	0
NON-JP	9	123	0	0	16	-12	4	5	120	120	0
NON-JP	10	85	0	0	25	-25	0	6	80	83	0
NON-JP	11	490	0	0	69	-10	59	12	476	476	0
NON-JP	12	710	0	0	20	4	24	19	726	690	36
NON-JP	13	360	0	0	14	-3	11	13	360	360	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	45	0	0	0	1	1	3	45	45	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	0	0	0	1	1	0
JP	6	18	6	0	15	0	15	1	8	12	-4
JP	7	85	0	0	45	-11	34	7	59	59	0
JP	8	92	0	0	58	-1	57	5	64	64	0
TOTAL		2339	6	0	411	-134	277	122	2663	2663	0

SEP 77 CEILING: 2663

SEP 77 AVERAGE GRADE: 10.32 (TARGET: 11.00)

Figure 5

PROMOTION POLICY MODEL - RUN 7

PERIOD 2

CATEGORY TYPE	GRADE	ABOARD SEP 77	HIRES	FIRES	PROMOTIONS FROM CATEGORY EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 78	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	0	0	1	-1	0	0	1	1	0
NON-JP	2	0	0	0	0	0	0	0	0	3	-3
NON-JP	3	24	6	0	10	0	10	3	12	42	-30
NON-JP	4	190	23	0	28	-1	27	10	186	186	0
NON-JP	5	127	0	0	24	-13	11	14	129	129	0
NON-JP	6	58	0	0	10	-2	8	5	61	61	0
NON-JP	7	90	0	0	28	-22	6	4	88	88	0
NON-JP	8	77	0	0	28	-22	6	2	75	75	0
NON-JP	9	120	0	0	16	-12	4	5	117	117	0
NON-JP	10	83	0	0	24	-24	0	6	81	81	0
NON-JP	11	476	0	0	67	-41	26	11	466	466	0
NON-JP	12	726	0	0	20	4	24	20	709	676	33
NON-JP	13	360	0	0	14	-3	11	13	367	360	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	45	0	0	0	1	1	3	45	45	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	0	0	0	1	1	0
JP	5	8	11	0	6	0	6	0	13	13	0
JP	7	59	30	0	31	0	31	5	59	59	0
JP	9	64	0	0	40	-13	27	3	64	64	0
TOTAL		2663	70	0	350	-198	202	112	2621	2621	0

SEP 78 CEILING: 2621

SEP 78 AVERAGE GRADE: 10.34 (TARGET: 11.00)

Figure 5 (continued)

PROMOTION POLICY MODEL - RUN 7

PERIOD 3

CATEGORY			PROMOTIONS FROM CATEGORY								
TYPE	GRADE	ABOARD SEP 78	HIRES	FIRES	EXPECTED	ADDITIONAL	ACTUAL	OTHER LOSSES	ABOARD SEP 79	GOAL	DEVIATION FROM GOAL
NON-JP	1	1	1	0	1	0	1	0	1	1	0
NON-JP	2	0	2	0	0	0	0	0	1	1	0
NON-JP	3	47	39	0	7	0	7	2	47	47	0
NON-JP	4	186	30	0	28	0	28	9	186	186	0
NON-JP	5	129	1	0	25	-10	15	14	129	129	0
NON-JP	6	57	0	0	10	0	10	5	57	57	0
NON-JP	7	88	0	0	27	-15	12	4	82	88	-6
NON-JP	8	75	0	0	28	-17	11	2	75	75	0
NON-JP	9	117	0	0	15	-9	6	5	117	117	0
NON-JP	10	81	0	0	24	-24	0	6	81	81	0
NON-JP	11	466	0	0	66	-37	29	11	466	466	0
NON-JP	12	709	0	0	20	4	24	19	695	676	19
NON-JP	13	360	0	0	14	-3	11	13	360	360	0
NON-JP	14	146	0	0	3	1	4	7	146	146	0
NON-JP	15	45	0	0	0	1	1	3	45	45	0
NON-JP	16	8	0	0	0	0	0	1	8	8	0
NON-JP	17	1	0	0	0	0	0	0	1	1	0
JP	5	12	11	0	10	0	10	1	12	12	0
JP	7	59	26	0	31	0	31	5	59	59	0
JP	9	64	0	0	40	0	40	3	58	64	-13
TOTAL		2621	110	0	349	-109	240	110	2621	2621	0

SEP 79 CEILING: 2621

SEP 79 AVERAGE GRADE: 10.25 (TARGET: 11.00)

Figure 5 (continued)

Office of Civilian Personnel. The six occupation groups are: scientists and engineers, other professionals, administrative, technicians, clerical, and other GS. The model was run at the occupation-grade level of detail. The results were then aggregated to reports by grade alone for overall evaluation.

The initial aboard and historical transition rates are based upon data from the Personnel Automated Data System (PADS) which is the Navy's centralized civilian personnel accounting system. The manpower goals are obtained by multiplying the initial aboard for the corresponding categories by a proportionality factor determined by the FYDP numbers for the appropriate years.

In order to eliminate invalid states (such as grade 10 scientists and engineers) and to increase numerical stability, those states having fewer than three people initially aboard are eliminated from consideration. This accounts for the absence of the grade 17 category from the DLP reports (there are actually two grade 17 scientists and engineers). The relative priority weights used in these tests are shown in Figure 6.

In Run A, the goal and promotion deviations are forced to zero by assigning them a high relative cost; hiring and firing is allowed to occur as needed. This results in a significant amount of firing in the middle grades, particularly in grade 12. If the excess personnel are retained rather than fired (Run B), the manpower ceiling constraint causes deficiencies in the lower grades in order to counterbalance the excesses in the middle grades.

The manpower goals can all be met without firing, provided the promotion rates are allowed to vary; this is shown in Run C. In this case, the

PROMOTION PLANNING MODEL
DIRECTOR OF LABORATORY PROGRAMS (DLP) EXAMPLE
RELATIVE PRIORITIES (COSTS) PER PERSON

NATURE OF ACTION	ALTERNATIVE A	B	C
Hires	1	1	1
Fires	10	100	1000
Above Goal	100	10	100
Below Goal	100	10	100
Promotions Above Historical Rate	100	100	10
Promotions Below Historical Rate	100	100	10

Figure 6

MANPOWER MODEL FOR DLP - RUN C

PERIOD 1

SCIENTISTS AND ENGINEERS

GRADE	ABOARD SEP 76	HIRES	FIRES	PROMOTIONS FROM GRADE EXPECTED	ADDITIONAL	ACTUAL	ABOARD SEP 77	GOAL	DEVIATION FROM GOAL
5	32	19	0	22	0	22	30	30	0
7	310	127	0	172	0	172	291	291	0
9	568	115	0	295	-4	291	533	533	0
11	1166	27	0	318	-315	3	1094	1094	0
12	3263	0	0	82	-42	40	3063	3063	0
13	2604	0	0	102	-83	19	2444	2444	0
14	1060	0	0	19	0	19	995	995	0
15	386	0	0	1	0	1	362	362	0
16	34	5	0	0	0	0	32	32	0
TOTAL	9423	293	0	1011	-444	567	8844	8844	0

Figure 7

MANPOWER MODEL FOR DLP - RUN C

PERIOD 2

SCIENTISTS AND ENGINEERS

GRADE	ABOARD SEP 77	HIRES	FIRES	PROMOTIONS FROM GRADE EXPECTED	ADDITIONAL	ACTUAL	ABOARD SEP 78	GOAL	DEVIATION FROM GOAL
5	30	20	0	21	0	21	30	30	0
7	291	133	0	162	0	162	237	287	0
9	533	133	0	277	0	277	525	525	0
11	1094	77	0	299	-155	144	1078	1078	0
12	3063	0	0	77	0	77	3016	3016	0
13	2444	73	0	95	-32	63	2407	2407	0
14	995	0	0	18	0	18	980	980	0
15	362	17	0	1	0	1	357	357	0
16	32	5	0	0	0	0	31	31	0
TOTAL	8844	458	0	950	-187	763	8711	8711	0

Figure 7 (continued)

MANPOWER MODEL FOR DLP - RUN C

PERIOD 3

SCIENTISTS AND ENGINEERS

GRADE	ABOARD SEP 78	HIRES	FIRES	PROMOTIONS FROM GRADE			ABOARD SEP 79	GOAL	DEVIATION FROM GOAL
				EXPECTED	ADDITIONAL	ACTUAL			
5	30	21	0	21	0	21	31	31	0
7	287	147	0	159	0	159	299	299	0
9	525	161	0	272	0	272	548	548	0
11	1078	139	0	294	0	294	1125	1125	0
12	3016	26	0	75	0	75	3149	3149	0
13	2407	215	0	94	0	94	2513	2513	0
14	980	25	0	18	0	18	1023	1023	0
15	357	38	0	1	0	1	373	373	0
16	31	8	0	0	0	0	33	33	0
TOTAL	8711	780	0	934	0	934	9094	9094	0

Figure 7 (continued)

MANPOWER MODEL FOR DLP - RUN C

PERIOD 1

TOTAL GS

GRADE	ABOARD SEP 76	HIRES	FIRES	PROMOTIONS FROM GRADE EXPECTED	ADDITIONAL	ACTUAL	ABOARD SEP 77	GOAL	DEVIATION FROM GOAL
1	5	3	0	2	0	2	5	5	0
2	159	115	0	76	0	76	150	150	0
3	511	233	0	212	0	212	479	479	0
4	1367	298	0	326	-2	324	1282	1282	0
5	1471	91	0	297	-50	247	1381	1381	0
6	666	4	0	120	-6	114	625	625	0
7	985	157	0	339	-6	333	924	924	0
8	311	2	0	85	0	85	292	292	0
9	1346	156	0	471	-37	434	1264	1264	0
10	412	2	0	78	-17	61	387	387	0
11	2592	27	0	442	-410	32	2433	2433	0
12	4415	0	0	102	-42	60	4144	4144	0
13	2862	13	0	115	-87	28	2687	2687	0
14	1125	0	0	20	0	20	1057	1057	0
15	398	1	0	1	0	1	373	373	0
16	34	5	0	0	0	0	32	32	0
TOTAL	18659	1107	0	2686	-657	2029	17515	17515	0

SEP 77 CEILING: 17515

Figure 8

MANPOWER MODEL FOR DLP - RUN C

PERIOD 2

TOTAL GS

GRADE	ABOARD SEP 77	HIRES	FIRES	PROMOTIONS FROM GRADE EXPECTED	ADDITIONAL	ACTUAL	ABOARD SEP 78	GOAL	DEVIATION FROM GOAL
1	5	3	0	2	0	2	5	5	0
2	150	114	0	72	0	72	147	147	0
3	479	242	0	199	0	199	473	473	0
4	1282	342	0	305	-2	303	1264	1264	0
5	1381	151	0	279	-27	252	1361	1361	0
6	625	12	0	113	-2	111	616	616	0
7	924	190	0	319	-1	318	911	911	0
8	292	8	0	80	0	80	287	287	0
9	1264	206	0	442	-2	440	1245	1245	0
10	387	6	0	73	0	73	381	381	0
11	2433	105	0	416	-196	220	2397	2397	0
12	4144	0	0	95	0	95	4080	4080	0
13	2687	95	0	107	-33	74	2646	2646	0
14	1057	0	0	19	0	19	1040	1040	0
15	373	19	0	1	0	1	368	368	0
16	32	5	0	0	0	0	31	31	0
TOTAL	17515	1498	0	2522	-263	2259	17252	17252	0

SEP 78 CEILING: 17252

Figure 8 (continued)

MANPOWER MODEL FOR DLP - RUN C

PERIOD 3

TOTAL GS

GRADE	ABOARD SEP 78	HIRES	FIRES	PROMOTIONS FROM GRADE EXPECTED	ADDITIONAL	ACTUAL	ABOARD SEP 79	GOAL	DEVIATION FROM GOAL
1	5	3	0	2	0	2	5	5	0
2	147	122	0	71	0	71	153	153	0
3	473	265	0	197	0	197	493	493	0
4	1264	410	0	302	0	302	1320	1320	0
5	1361	228	0	275	-7	268	1420	1420	0
6	616	27	0	110	0	110	642	642	0
7	911	238	0	314	-1	313	951	951	0
8	287	24	0	79	0	79	299	299	0
9	1245	273	0	434	0	434	1299	1299	0
10	381	28	0	72	0	72	398	398	0
11	2397	242	0	409	-5	404	2502	2502	0
12	4080	56	0	93	0	93	4261	4261	0
13	2646	251	0	106	0	106	2762	2762	0
14	1040	28	0	19	0	19	1086	1086	0
15	368	41	0	1	0	1	385	385	0
16	31	8	0	0	0	0	33	33	0
TOTAL	17252	2244	0	2484	-13	2471	18009	18009	0

SEP 79 CEILING: 18009

Figure 8 (continued)

number of promotions is substantially reduced, particularly from grade 11. Figure 7 shows this data for the scientists and engineers and Figure 8 shows the summary data by grade.

Conclusion

Given the assumptions on which the PPM is based, it is apparent from running the model for the NUSC and DLP that the manpower goals as given cannot be met without either firing the excess personnel or cutting back on promotions. One reason is that, due to assumed reductions in the workforce requirements, the goals and ceilings are less than the initial population. A second reason is that the promotion rates tend to decrease with grade level, which results in an accumulation of personnel at the middle grades, particularly grades 11 and 12 of the professional occupational series.

If the choice is between reduction in promotions and firings, the employees affected would certainly prefer the former. Both of these courses of action, or even the threat of them, will tend to motivate people to leave the organization on their own, which in turn reduces or even the threat of them, will tend to motivate people to leave the organization on their own, which in turn reduces or even eliminates the need to actually carry out these adverse actions. The problem with this tactic is that it is the most competent people, having the best prospect of jobs elsewhere, who will be most likely to leave. Selective promotion of the most qualified people is perhaps a way around this difficulty. Such a promotion system would have to be accomplished by a promotion board concentrating on the grade levels which constitute the long term cadres of personnel.

The estimation of the manpower requirements could be improved through the use of a workload planning system.[1/] Such a system would have a list of projects to be completed as input. It would compute the total manpower resources by skill category needed to complete those projects. Such a project is now underway within DLP on a prototype basis. The promotion planning model tests showed the PPM to be a quite useful improvement to the recruiting requirements model. The tests have also helped to open the way to the development of a comprehensive workload planning system for the naval laboratories.

1/ See /3/ for a initial study concerning this proposed workload planning system.

APPENDIX A

PROMOTION PLANNING MODEL DESCRIPTION

The version of the PPM used in the NUSC and DLP studies involves the manpower dynamics alone. The manpower systems are heavily constrained by personnel ceilings and high grade controls with more than adequate funding available and thus the budget constraints are not necessary. The model is designed to provide estimates of the numbers of people that should be hired, fired, or promoted consistent with future manpower requirements. The objective of the model is to meet the manpower requirements as closely as possible subject to the constraints on the manpower system.

The structure of the PPM is shown in Figure 9 which is a translation into word equations. The objective of the PPM as indicated above is to minimize the sum of the costs of being over or under the manpower requirements of weighted numbers of hires and fires, and of weight numbers of transfers to effect greater than historical numbers of promotions/demotions. This objective is subject to a number of constraints. First, the number at the start in each job category is set equal to the initial population. The base population is then submitted to a matrix of movement or transition rates which distinguishes probabilistically between those staying in a particular job category, those being promoted at the historical rate, and those leaving the organization. The result of this is the numbers in each job category before transfers using historical rates for retention and promotion. To these numbers for each job category is added the hires (or fires) and excess transfers in (or transfer) deficiency which equals

PROMOTION PLANNING MODEL DESCRIPTION

Objective: Minimize cost (measured by relative priorities) of being over/under manpower requirements and of weighted numbers of hires and fires and weighted numbers of promotions above/below historical rate.

Subject to:

Number in Each Job Category in Each Period	−	Possible Amount Over	+	Possible Amount Under	=	Manpower Requirements by Job Category				
Number in Each Job Category At Base Period					=	Initial Population				
Number Remaining in Each Job Category at Present Period Using Historical Transition Rates	−	Hires	+	Fires	−	Excess Transfers	+	Transfer Deficiencies	=	Number in Each Job Category at Present Period
		Additional Transfers for Flexible Promotions in Each Period			≤	Historical Retention in Each Job Category in Each Period				
Sum of Number in Each Job Category in Each Period					≤	Total Manpower Ceiling in Each Period				

Figure 9

the number at the next time period. This process is repeated for each of the periods in the forecast. Constraints have been added to the model to ensure that the number of transfers for flexible (more than historical) promotions or demotions is less than or equal to the historical retention in each job category. This ensures that these additional transfers are possible. Constraints are also set for each time period for the total manpower limitation or ceiling. Here, the condition is set that the sum of the number in each job category in a given period must be less than or equal to the total manpower limitation for that period.

For solution purposes the PPM is transformed into the linear programming matrix shown in Figure 10. A linear programming matrix generator is used to develop the inputs in the form that is shown. Upon solution a report writer is used to develop the suitable management reports.

LINEAR PROGRAMMING MATRIX FOR THE PROMOTION PLANNING MODEL

ROWS \ COLUMNS	ON-BOARD	HIRES	FIRES	POSITIVE GOAL DEVIATION	NEGATIVE GOAL DEVIATION	EXCESS TRANSFERS	TRANSFER DEFICIENCIES	RELATION	RHS
COSTS		γ γ	δ δ	α α	β β	θ θ	ξ ξ		
GOAL EQUATIONS	I I			-I -I	I I			= =	Manpower Requirements
TRANSIT CONDITIONS	I -M I -M I	-I -I	I I			-T -T	T T	= = =	Initial Population 0 0
MAXIMUM TRANSFER DEFICIENCIES	$-M_{ij}$ $-M_{ij}$						T_{ij} T_{ij}	$\leq$ $\leq$	0 One equation for each T_{ij} = 1 (admissable promotion flexibility) 0
MANPOWER CEILING	e^T e^T							≤ 1 ≤ 1	Total Ceiling

M_{ij} = historical transition rate from category j to category i

T_{ij} = 1 if [grade of category i] - [grade of category j] = 1 or 2 and $M_{ij} \geq 0.001$

= 0 otherwise

Figure 10

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There has been a great deal of concern within the Navy with regard to the control of the grade structure of civilians. These concerns have manifested themselves in recent times in the form of manpower ceiling allocations, the allocation and control of high grade positions, average grade constraints, promotion restrictions, and hiring freezes. In an attempt to deal with these problems, a promotion policy model (PPM) has been developed using a version of the Flexible Equal Employment Opportunity Model (FEEO) of Charnes, Cooper, Lewis, and Niehaus. Two applications of the PPM are presented, one using the graded employees at the Naval Underwater Systems Center (NUSC) and the other using the graded personnel of the Director of Laboratory Programs which consists of all the Navy RDT&E,N Laboratories commanded by the Chief of Naval Material. The results of the model runs for NUSC and DLP indicate that the manpower goals as given cannot be met without cutting back on promotions. The specific alternatives along with the magnitudes of the promotion reductions suggested by the model are provided in the paper.